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A NEW DEEP-WATER CHITON  
FROM THE  
NORTHEASTERN PACIFIC

By

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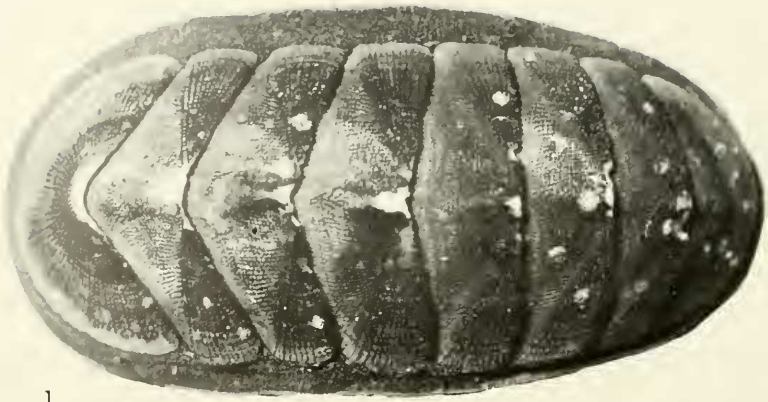
and

Ian McT. Cowan

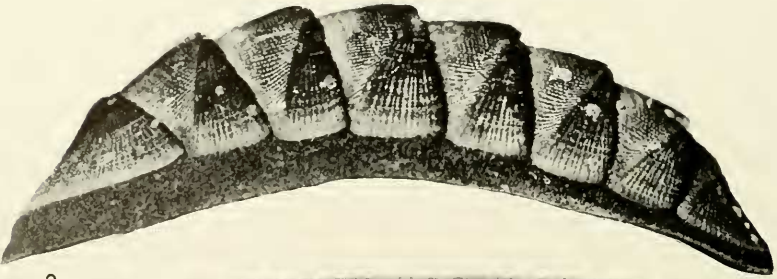
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ABSTRACT. *Ischnochiton abyssicola*, a new species of deep-water chiton from the northeastern Pacific, is described and illustrated in detail. Comparison is made between this and *Ischnochiton stearnsi* Dall, 1902, figured for the first time from the holotype specimen in the United States National Museum, and *Ischnochiton (Tripoplax) trifidus* (Carpenter, 1864), which is also figured.

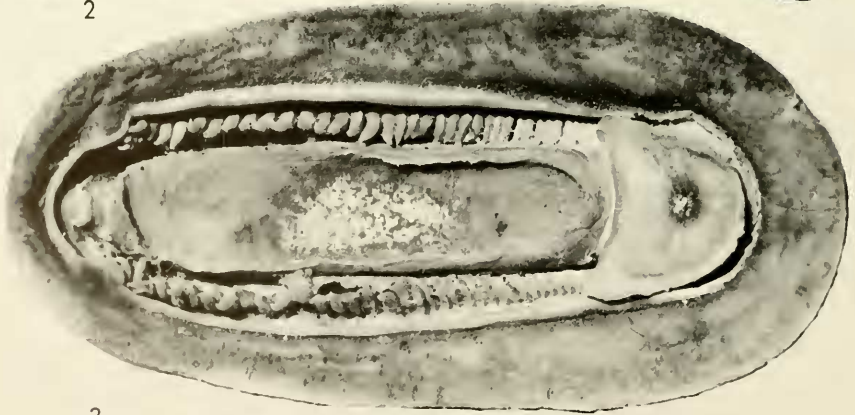
A series of exploratory dredgings undertaken in 1964 in the northeast Pacific by the Fisheries Research Board of Canada research vessel *B. G. Reed* has produced several specimens of a large undescribed chiton. The first was collected by I. McT. Cowan from among fishes brought up in an otter trawl operating off the Semidi Islands, Alaska, in 140-118 fathoms. Others were collected subsequently from Queen Charlotte Sound, British Columbia, and off Cape Flattery, Washington, in the 500-fathom range. Another was dredged off the coast of Oregon in over 1000 fathoms by the Oregon State University De-



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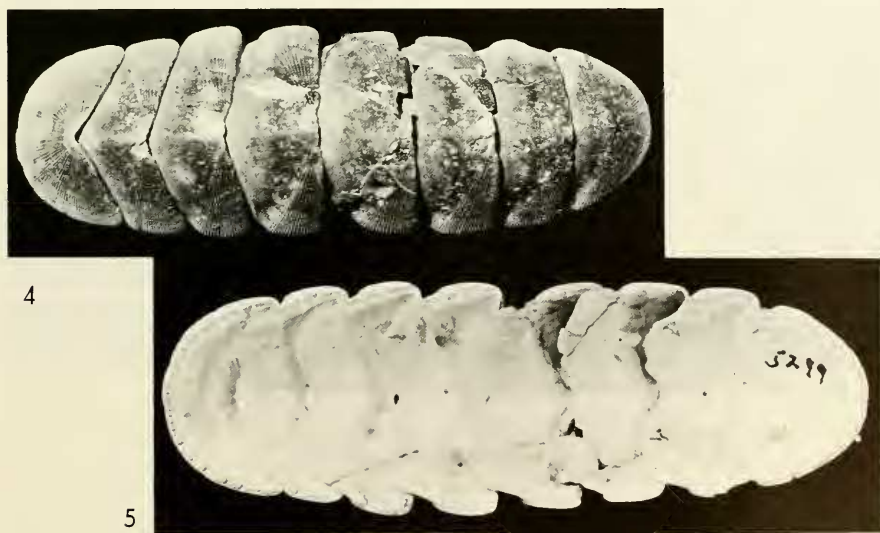


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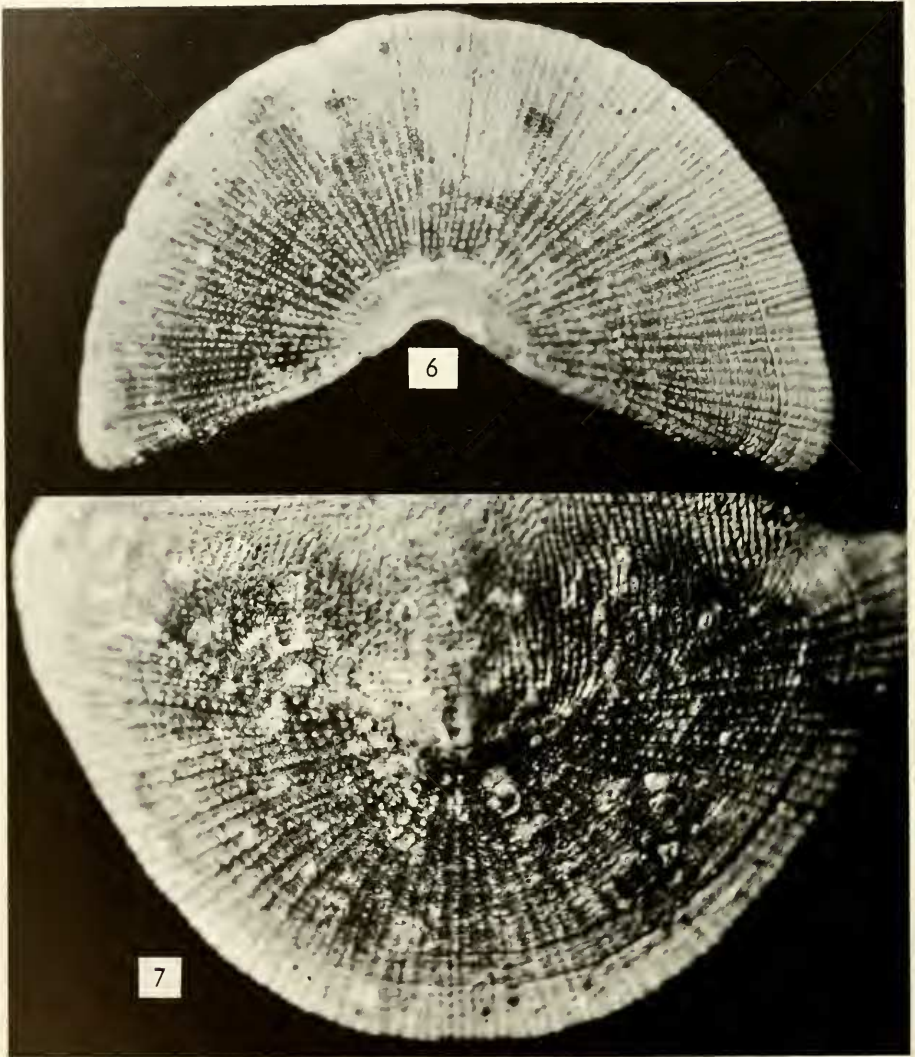
Figures 1-3. *Ischnochiton abyssicola* Smith and Cowan, new species. Holotype (CAS Invertebrate Zoology Type Series no. 287) from 470-480 fathoms, Queen Charlotte Sound, British Columbia, Canada. (1) dorsal; (2) side; and (3) ventral views. Length, 46 mm.

partment of Oceanography. A further specimen was obtained by the United States Bureau of Commercial Fisheries in 291-300 fathoms off the mouth of the Columbia River. It would appear, therefore, that this chiton has a rather wide distribution along the northwest coast of North America from the Aleutian Islands as far south as Oregon, and that it may turn out to be a reasonably common species in depths ranging from over 100 to more than 1000 fathoms with its bathymetric mid-point in the vicinity of 500 fathoms.

This new species belongs in the family Ischnochitonidae, genus *Ischnochiton* Gray, 1847, the genotype being the South African *I. texilis* (Gray, 1828). *Ischnochiton*, *sensu lato*, is widespread, containing many described species. Numerous attempts have been made to divide the group into smaller units of more or less closely related forms and thus far no less than sixteen valid names have been used to designate sections, subgenera, or genera, the systematic positions chosen depending on the current view of taxonomists who have endeavored to solve the complex problem (Smith, 1960, pp. 55-56). Of all the names available for use as possible subgenera of *Ischnochiton*, none appears to encompass both the general characters and the bathymetric range of specimens at hand. In spite of this we hesitate to add a new subgeneric taxon to cover this new species until further critical work has been done on species assigned to the genus *Ischnochiton* in order to define species and group relationships more clearly and place them in a proper systematic order.



Figures 4-5. *Ischnochiton abyssicola* Smith and Cowan, new species. Paratype (University of British Columbia Museum of Zoology Collection) from 149-118 fathoms south of the Semidi Islands, Alaska. (4) dorsal, and (5) ventral views. Length (assembled shells only), 89.8 mm.



Figures 6-7. Same specimen as figures 4 and 5. Enlarged dorsal views of head valve (figure 6) and tail valve (figure 7). Width of head valve, 25.5 mm.; of tail valve, 22.9 mm.

*Ischnochiton abysicola* Smith and Cowan, new species.

(Figures 1-19.)

GENERAL DESCRIPTION. Adult animals large for the genus, ranging up to nearly four inches in total length, elongate with a length somewhat more than

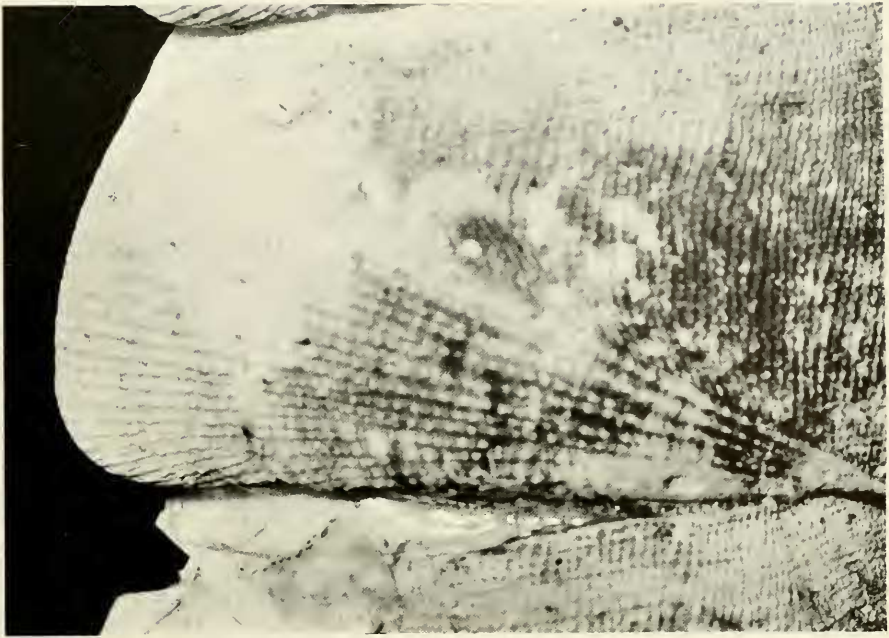


Figure 8. Same specimen as figures 4-5. Enlarged dorsal view, left side of intermediate valve iv. Maximum distance, jugum to anterior margin, 20.6 mm.

twice the width, and with straight sides. Dorsal sculpture on the head valve, lateral areas of intermediate valves, and posterior area of tail valve consisting of numerous, closely spaced, diagonal, beaded riblets or of more widely spaced, granulated ribs, the lateral areas well defined. Insertion plates on the head valve cut by many deeply incised slits, of intermediate valves by one to three slits, and of tail valve by twelve or more slits. Teeth between the slits short and blunt, roughly lacinated at their summits and on the outside, especially on the head and tail valves, but not pectinated as in the Chitonidae. Eaves narrow, solid. Girdle armature of erect, small, closely packed, inwardly curving, blunt spinules, with rounded tops giving the girdle a finely divided, pebbly surface. Gills ambient.

**HOLOTYPE.** A medium-sized adult, its length 2.3 times its width. Head valve nearly semicircular, the side-slope straight, the apex slightly everted. Intermediate valves with straight posterior margins and slightly convex side-slopes, making an angle of about  $100^\circ$  with an acute jugum; lateral areas prominently offset from the lateropleural areas, narrowly triangular, slightly rounded at the side margins. Tail valve with posterior margin broadly ovate, the posterior area set off from the anterior by a rib of a wide V-shape that is most



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prominent at the margin and gradually becomes obsolete toward the low, centrally placed mucro.

Dorsal sculpture of the head valve, lateral areas of the intermediate valves, and the posterior area of the tail valve consisting of closely spaced, diagonally arranged, somewhat anastomosing, finely beaded riblets, the beads occurring generally in curving rows paralleling the lines of growth. Counted at the valve margins there are about 85 riblets on the head valve, 11-13 on the lateral areas of the intermediate valves, and 65 on the posterior area of the tail valve. The lateropleural areas of intermediate valves and the anterior area of the tail valve are sculptured with a more or less parallel, somewhat sinuous network of very fine longitudinal riblets crossed by less prominent lines of growth, forming a finely decussated pattern not raised into beads as on the other shell areas. The jugal areas are not prominently outlined and have much the same sculptural pattern, the fine riblets sweeping down from the jugum anteriorly in curving, V-shaped arrangement. No enlarged, scattered pustules occur on the end valves or on the lateral areas of the intermediate valves as in some species of the related genus *Lepidozona*.

The girdle, about 4 mm. wide, is relatively narrow for the size of the animal, the dorsal side being thickly set with smooth, stout, inwardly curved, scale-like spinules, somewhat resembling diminutive surfboards in general form. They are erect, crowded but not imbricate, and are in close contact with each other being randomly placed in their short-axis orientation. They vary in size and shape somewhat, also in a random manner. A narrow band around the outside margin of the girdle has the stout spinules replaced by a fringe of slender white spines. At the junction of the two spinous areas there is a continuous row of fine setae, the longest 1 mm. in length. The ventral side of the girdle has a surface composed of closely appressed, parallel fibers directed crossways. These are of random length and have their tips free from the surface so that the entire undersurface of the girdle is minutely roughened. They vary in color from white to brown. At the girdle margin they extend free, forming the band of delicate fringing spines.

The foot terminates in a horseshoe-shaped oral plate, about as broad as long. Gills are ambient, the anteriormost branchiae being immediately beneath or just in front of the posterior lappet of the oral plate. There are 41 branchiae in the left branchial groove and 42 on the right. At the level of the posteriormost branchiae, the inside pedal margins of the girdle project inward in the form of a pronounced lappet. The anal opening is well behind the foot.

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Figures 9-11. Same specimen as figures 4-5. Enlarged views of ventral side. (9) Head valve in normal position overlapping the sutural laminae of intermediate valve ii showing slits and teeth in the insertion plate. (10) Looking down on the insertion-plate margins of intermediate valves ii, iii, and iv showing multiple slits and teeth. (11) Tail valve in normal position showing configuration of slits and teeth.

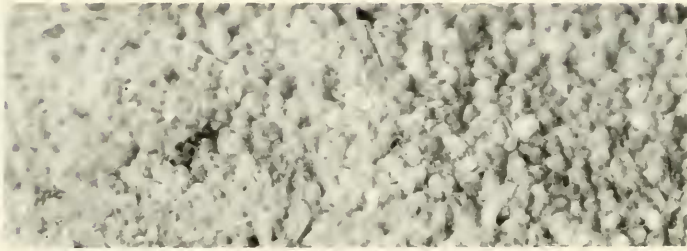


Figure 12. Same specimen as figures 4-5. Portion of girdle, much enlarged, showing girdle scales.

Dorsal color of the valves is a dark red-brown, especially on the lateral areas of the intermediate valves, becoming darker toward the jugum. To the unaided eye the girdle appears to be a uniform blackish brown, but under magnification the rounded tips of the spinules are a random mixture of black, brown, and whitish colors.

Measurements are: length, 46 mm.; width, 19.5 mm.; height, 9 mm.

**HOLOTYPE AND PARATYPES.** Holotype, a slightly curled perfect specimen, preserved in alcohol, dredged in 470-480 fathoms (860-878 meters) WNW. of Triangle Island, Queen Charlotte Sound, British Columbia, Canada (lat.  $31^{\circ} 09' W.$ ) by M/V *G. B. Reed*, Fisheries Research Board Station no. 863, haul no. 63-214, D. B. Quayle and I. McT. Cowan, collectors, September 11, 1964. Deposited in the California Academy of Sciences Invertebrate Zoology type series no. 287. The holotype is of medium size for the species and is somewhat contracted from preservation. Other specimens, here designated as paratypes, are as follows:

(1) Three specimens collected with the holotype, preserved in alcohol: (a) A damaged adult measuring approximately 60 mm. in length; (b) A perfect adult measuring approximately 48 mm. in length, 23 mm. in width, and 10 mm. in height; (c) A fairly perfect juvenile measuring in length, 27.5 mm., width, 13.5 mm., and height, 4.8 mm. Numbers of slits in this partially disarticulated third specimen are 14+ in the incomplete head valve and 15 in the tail valve.

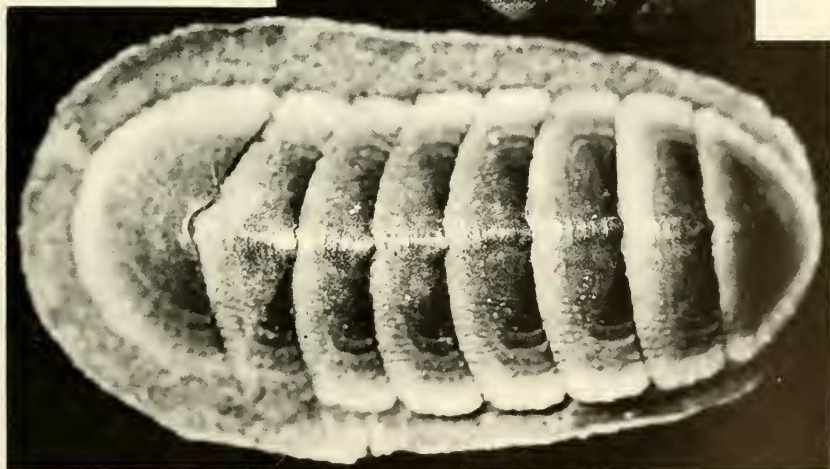
(2) A single very large adult specimen from 140-118 fathoms (256-216 meters) south of the Semidi Islands, Aleutian Chain, Alaska (lat.  $55^{\circ} 15' N.$ ; long.  $188^{\circ} W.$ ), gravel bottom, I. McT. Cowan, collector; August, 1964, University of British Columbia Museum of Zoology, no. 5299 (Cowan collection). Animal preserved in alcohol. The somewhat damaged valves have been repaired and assembled separately. Measurements of valves only: length (assembled), 89.8 mm.; maximum width, 29.3 mm.; height, 15.2 mm.; angle of divergence,  $102^{\circ}$ .



(3) Two badly damaged adult or subadult specimens from 534 fathoms (975 meters) off Swiftsure Bank, Washington (lat.  $55^{\circ} 15' N.$ ; long.  $156^{\circ} 18' W.$ ), gravel bottom, Station 835, I. McT. Cowan and D. B. Quayle, collectors, September 6, 1964, University of British Columbia Museum of Zoology, no. 5369 (Cowan collection). The shells of one specimen were complete enough to assemble apart from the preserved animal. This measures: length, 52 mm.; width, 21.5 mm.; height, 8.5 mm., the slit formula being 22-2/3-14. All valves of the second specimen were too shattered to assemble, but it appears to be about the same size as the other. There are 16 slits in the nearly complete tail valve of this latter specimen. This lot also contains four juvenile specimens ranging in length from 6.5 - 14.1 mm.



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Figures 13-14. *Ischnochiton abyssicola* Smith and Cowan, new species. Enlarged views of juvenile specimens. (13) Paratype (CAS Invertebrate Type Series no. 288) from 2000 meters (1093 fathoms) off the coast of Oregon. Length, about 20 mm. (14) Paratype from 534 fathoms off Swiftsure Bank, Washington. Length, 14.1 mm.

(4) A juvenile with tail valve missing from 1093 fathoms (2000 meters) off the coast of Oregon (lat.  $44^{\circ} 33.5' N.$ ; long.  $125^{\circ} 14.6' W.$ ), collected July 6, 1962 with an anchor dredge by R/V *Acona*, cruise no. 6207, Oregon State University accession no. 06-M-06 (Department of Oceanography). The length of this specimen is approximately 20 mm., the slit formula being  $16-2/3-?$ . Deposited in the California Academy of Sciences, Department of Invertebrate Zoology, type series no. 288.

Another specimen was taken in an otter-board trawl in 291-300 fathoms SW. of the mouth of the Columbia River in lat.  $45^{\circ} 59' N.$ ; long  $124^{\circ} 49' W.$  by the R/V *Commando* of the U. S. Bureau of Commercial Fisheries at Station A-42, collected September 13, 1961. It is a large adult specimen in the Department of Geology, Stanford University.

Paratypes from the type locality have been deposited in the Division of Mollusks, U. S. National Museum; and in the National Museum of Canada, Ottawa.

EXTENDED DESCRIPTION AND DISCUSSION. Because the holotype is a perfect specimen we decided to leave it intact and rely on paratype specimens for a description of the ventral surfaces of the valves and other features. The large paratype of *Ischnochiton abyssicola* from 140-118 fathoms off the Semidi Islands was used for this purpose, reference being made also to the assembled valves of the paratype from 534 fathoms off Swiftsure Bank, Washington, and to the two juvenile specimens.

Dorsally, the numbers of riblets on the Semidi Island paratype are greater than on the holotype, being 125 on the head valve, 11-13 on the lateral areas of the intermediate valves, and about 80 on the posterior area of the tail valve. On the youngest, 27.5 mm. specimen collected with the holotype, the corresponding riblet count is 36+, 6-7, and 35, respectively. On the Oregon specimen, which is somewhat smaller, the number of riblets is 46 on the head valve, and 9-11 on the lateral areas of the intermediate valves. Thus it seems obvious that this sculptural feature varies with the size and probably with the age of the animal.

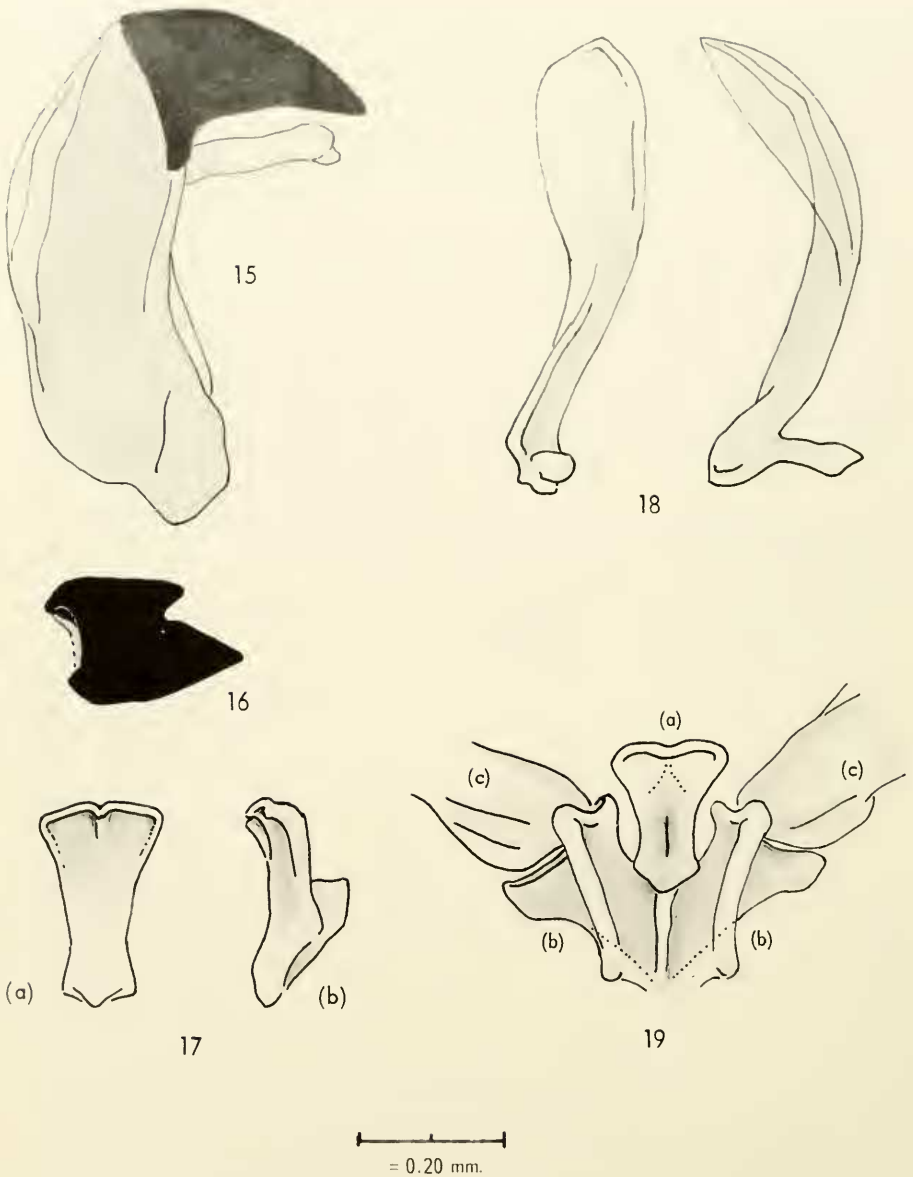
Another dorsal feature, seen only on disarticulated valves ii through viii, is a small rounded extension of the posterior margin of the tegmentum at the sutural sinuses to form well developed false beaks.

Ventrally, the tegmentum of valves i through vii on the large Semidi Island paratype forms a narrow apical area, 1.8-2.3 mm. wide, at the apex, becoming much reduced in width toward the valve margins. Articulation of the head valve terminates in a narrow insertion plate cut into many blunt teeth by deeply incised slits. The first five teeth on each side are rather broad, about equally spaced, and are marked further by three to five shallow grooves at their summits that extend over the outside surfaces. Toward the

center of this valve the teeth are much broken up by many closely spaced, deeply incised slits, resulting in a total of about 30 in all. On the intermediate valves the insertion plates are faintly grooved on the outside and are cut by two shallow slits on each side, with indications of a third subobsolete one just behind the posterior valve margin. Insertion plate of tail valve cut by about 12 irregularly placed slits into a series of blunt teeth, strongly grooved on the outside, with a tendency toward the center of the valve to be broken up by 6 or 7 shallow subsidiary slits. The sutural laminae are smooth, broad, rounded, sharp-edged, and continue the gentle curvature of the valve margins to the rather narrow, generally semicircular-shaped sutural sinus. The latter is crossed by a narrow sutural plate set off from the ends of the sutural laminae by shallow notches. On the tail valve the sutural laminae are a bit truncated at the anterior ends and the sutural sinus is squared off by a much more prominent sutural plate that is delicately grooved on the outside. The muscle scars on the articulamentum of both head and tail valves form a rough, irregular pattern. On the intermediate valves they consist of a low, broad V-shaped ridge, widest at the jugum and tapering toward the valve margins. All valves of this large specimen have narrow solid eaves that do not project beyond the edges of the insertion plates. No slit rays occur.

The articulamentum of younger specimens with thinner shells is porcellaneous and less chalky than in older ones; the slits are more regularly placed, the teeth not being divided by subsidiary slits although the tendency toward subsidiary slitting begins to show on the head valves. Well developed slit rays are present in the valves of these younger specimens. Their color is lighter brown dorsally, with the valve margins whitish.

**RADULA.** The radulae of two animals, one from the large Semidi Island specimen and another from a somewhat smaller specimen from off Triangle Island, were extracted and studied by Mr. Spencer R. Thorpe, Jr., of El Cerrito, California, who also has contributed the accompanying drawings (figures 15-19), which speak for themselves. He is of the opinion that the radula of *I. abyssicola* is clearly of the *Lepidozona* type, taking into consideration the configuration of all the separate parts and radula size in relation to the size of the animal. Within these general limits Thorpe says that the subgenus *Tripoplax* Berry, 1919, represented by the single species *Ischnochiton trifidus* (Carpenter, 1864) from Alaskan waters has the same bidentate cusps on the major laterals as *I. abyssicola*. However, he points out that the broad and massive character of the spatulate uncinals, the markedly bilobed configuration of the alate process, and the general ruggedness of the radular parts distinguish *I. abyssicola* from *I. trifidus*, although the two species appear to be quite closely related on the basis of the radula only.



Figures 15-19. *Ischnochiton abyssicola* Smith and Cowan, new species. Radula details. (15) Major lateral, large paratype from the Semidi Islands, viewed from the anterior. The outline of the cusp where it joins the shaft may not be completely correct as it is not clearly defined because of the thickness and translucence of the shaft. (16) Cusp of major lateral, smaller paratype from off Triangle Island,

COMPARATIVE RELATIONSHIPS. *Ischnochiton abyssicola* is by far the largest *Ischnochiton* ever taken from deep water of the Pacific Coast of North America. In size and general shape it is much like the larger ischnochitonid species in the genus *Stenoplax*, such as the Panamic *S. magdalenensis* (Hinds) and the Californian *S. conspicua* (Dall), *S. heathiana* Berry, and *S. fallax* (Carpenter). The configuration of the head and tail valves of *I. abyssicola* is much the same as in these species of *Stenoplax*. However, the finely beaded dorsal sculpture, the tendency toward multiple slitting of the end valves with age, and the peculiar girdle decoration all are markedly different from *Stenoplax*. Moreover the benthic range of *I. abyssicola* leaves a wide gap in habitat, as all the larger species of *Stenoplax* live in a low intertidal or high subtidal zone; so far as we are aware there are no dredging records for any of the latter. The geographical range of the new species, based on the material at hand, extends well to the north of any known member of the genus *Stenoplax*, the northernmost record being Vancouver Island for *S. fallax*, and Coos Bay, Oregon, for *S. heathiana*.

The relationship to the Alaskan *Ischnochiton trifidus* based on radular characters only, has already been mentioned. *Ischnochiton trifidus* (figure 20) also has multiple-slitted insertion plates in the intermediate valves, but the dorsal sculpture of the valves and girdle armature of solid, rather convex scales are different from *I. abyssicola*. While the bathymetric range of *I. trifidus* is not well known, it is generally found in moderate depths widely separated from the abyssal niche of *I. abyssicola*. A possible other near relative is the little-known *Ischnochiton stearnsi* Dall, 1902, until recently based on a single specimen in the United States National Museum (holotype no. 109024) collected by the U. S. S. *Albatross* in 391 fathoms off the Farallon Islands, California. Another specimen of *I. stearnsi* was dredged by the R. V. *Velero IV*, cruise no. 641, on February 13, 1965, in 255 fathoms, 7.2 miles 190° True from Long Point, Santa Catalina Island, California (Los Angeles County Museum no. 10328). Comparison of this second specimen, which was made available by James H. McLean of the Los Angeles County Museum, with the holotype loaned through the courtesy of Dr. Harald A. Rehder of the U.S. National Museum (figure 21) leaves no doubt as to its identity. *Ischnochiton stearnsi* is a relatively small species, around 25 mm. in length, and has a more or less typically granular *Lepidozona*-type dorsal sculpture with no enlarged scattered pustules on the valve surfaces. Ventrally some of the intermediate valves are double-slitted although there seems to be no tendency toward subsidiary slit-

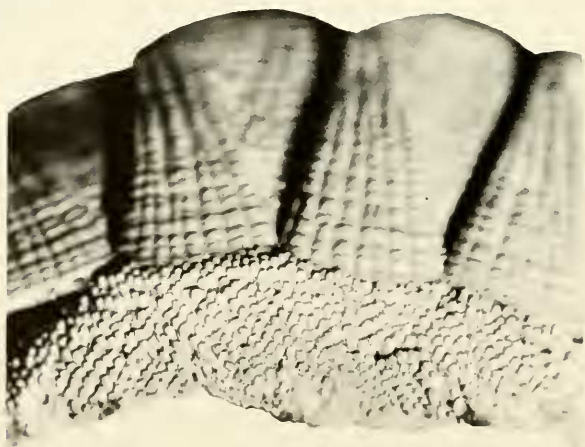
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Queen Charlotte Sound. Ventral Aspect. (17) Detail of central tooth, Semidi Island paratype: (a) from directly above, (b) from the side. (18) Two views of a spatulate uncinal, Semidi Island paratype. The smaller branching part at the bottom of the bottom of the figure is directed anteriorly in the complete radula. (19) Detail of central portion of radula, Semidi Island paratype: (a) central tooth, (b) minor laterals, (c) bases of major laterals. Dorsal view.

ting in the end valves. The general configuration of the teeth in the insertion plates and the similarity of the girdle scales of both *I. abyssicola* and *I. stearnsi* seem to us to be sufficient evidence to warrant placing the two in the same



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Figure 20. *Ischnochiton trifidus* (Carpenter). Dorsal view of adult specimen from Auke Bay, Alaska. Jack E. Bailey, collector. Length, 37.6 mm.

Figure 21. *Ischnochiton stearnsi* Dall. Enlarged side view of the holotype (United States National Museum no. 109024) from 391 fathoms off the Farallon Islands, California, showing intermediate valves iii-vi, inclusive, and girdle scales. Height, 6 mm.

species-group. Although the sculptural pattern of *I. stearnsi* is quite different from that of *I. abyssicola* this appears to be a specific rather than a subgeneric or generic difference in this instance.

In conclusion, the authors wish to express special thanks to Mr. Spencer Thorpe for his study of the radula of the new species and for his cooperation in providing excellent illustrations (figures 15-19) for inclusion in this paper; to Mrs. G. Samuel Alspach of the Department of Oceanography, Oregon State University, for supplying the Oregon specimen; and to Mr. Maurice Giles and Dr. G. Dallas Hanna of the California Academy of Sciences for assistance with the production of the illustrations. Figures 1-14 and 20-21 are from Kodachrome slides by the senior author.

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